The Effects of High Carbon-in-Ash on Electrostatic Precipitator Performance

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Summary

The efficiency of ash removal is receiving mounting interest with the tightening of legislation on particulate emissions. In the UK a limit of $50mg/Nm^3$ now has to be met. The amount and nature of unburned carbon in the ash is thought to affect the performance of electrostatic precipitators, which are commonly used to remove fly-ash from power-station flue gases. At Nottingham University this has been studied in an electrostatic precipitator rig that simulates the conditions in a full size power station installation. The rig consists of a parallel plate precipitator which is 4.5m long, 0.35m high and has a width between the collector electrodes of 0.3m. The length and width are typical of full-scale commercial precipitators but the height is much less. Gas flows of around $0.1ms^{-1}$ are used at temperatures around 110-130^{o}C.

A series of runs have carried out which have demonstrated that the rig achieves similar collection efficiencies to those achieved on full-scale plant of around 85-90%. In these runs it was quite clearly shown that the carbon content of the ash collected in the precipitator increases significantly with distance from the inlet. The quantities collected in these sections are small, with the bulk of the carbon, as with the bulk of the ash, being collected in the first sections. But the concentration of carbon near the end of the rig shows that it is more difficult to collect and takes longer to be attracted to the walls or settle. Further to this, five different size fractions were prepared by sieving the pfa to provide feed material of varying size and carbon content. It was shown that the carbon content in the different size fractions increases down the precipitator, clearly indicating the increased difficulty in collecting carbon-rich particles. The effect increases with increase in particle size with the >106µm size fraction having about 10 times the percentage of carbon compared with the <38µm fraction. The collection efficiency was also shown to fall considerably for the larger, higher carbon content particles.

In parallel with the rig trials work is being carried out to characterise the nature of the carbon found in the pfa. Initial work has concentrated on methods to concentrate the carbon from the pfa in order that it can be examined for morphological features, reactivity and other relevant parameters. The techniques investigated include: density separation in a dense liquid medium, incipient fluidisation and acid demineralisation. All the techniques have advantages and disadvantages, however, it is evident from the results that realistic examination of the carbon material in the pfa requires a technique which looks at the whole pfa material. Density separation techniques need to be carried out on sieved size fractions and it is likely that the incipient fluidisation technique preferentially separates the less dense chars to the surface and the denser solid material is left behind in the ash. Overall, acid demineralisation provides a carbon material from whole pfa which is representative of all of the carbon types present. However, it requires more process time and produces only small quantities of sample.

The work on both the precipitator and carbon characterisation continues with a new contract recently obtained from the European Coal and Steel Community.